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### **Paper No. 18: Analysis of Competi- tiveness in Commercial Shipbuilding**

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# 1995 SHIP PRODUCTION SYMPOSIUM

## Commercial Competitiveness for Small and Large North American Shipyards

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## Analys Analysis of Competitiveness in Commercial

### Shipbuilding

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#### ABSTRACT

The paper consists of two elements i.e.:

- the analysis of the competitiveness of the Dutch shipbuilding industry, and
- the structural and organizational changes in the Dutch shipyards since 1983, based on market approach and cost reduction.

The objective of a study completed in 1993 was to gain insight into the competitive position of the Dutch shipbuilding industry for seagoing merchant ships. Different indicators were developed and analyzed for the period 1984-1992. Labor cost and exchange rates are the two parameters which enable the assessment of the development of the labor cost, which is calculated in US\$ per cgt. For selected countries the level of productivity (and thereby the labor cost per cgt<sup>1</sup>) has been adjusted to an estimated degree of subcontracting. The Netherlands shipbuilding industry shows an average share in the AWES<sup>2</sup> production of about 8-9 percent in the period 1984-1992. This indicates that a

competitive position has been maintained. Some Asian countries and Poland show a lower level of labor cost per cgt than The Netherlands.

The changes in structure and organization of the Dutch shipbuilding industry, which concentrates mainly on niche-markets and special types of vessels, is discussed. The niche-market approach has been leading to product specialization at several yards. The expectations for the shipbuilding market in Western Europe are discussed briefly.

#### INTRODUCTION

The international competitive position of the shipbuilding industry in the Netherlands got the attention of shipbuilders and administrations as soon as Dutch shipowners started to place orders in Japan (late '60s - early 70s). Delegations of shipbuilding experts visited Japan to study building methods, organization and lay-out of shipyards, and the construction of ships.

The findings of the delegations confirmed that low labor cost were not the only factor for the success of the Japanese builders; but that these were combined with high productivity, which was the result of an analytical approach of the production process. Production friendly and simple designs of details, well organized production systems, clean shipyards, building methods which were reducing lead times, and many small, apparently not important, organizational details were noticed and explained the differences in cost. The findings showed the upcoming changes in the industrial climate.

In the same period the North-Sea was developed as an oil and gas producing area. The industry was booming and the economy growing as labor productivity increased. Some shipyards concentrated on this industry and floating and fixed platforms were built. This regional market was a matter of competition between regional builders from North-West Europe. However, the shipyards which were active in the international market, meeting Japanese competition,

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<sup>1</sup> A common measurement of production of the shipbuilding industry is Compensated Gross Tonnage (cgt), which is defined as a unit of shipyard capacity, derived from multiplying the gross tonnage by a coefficient reflecting the "standard manhour" required for production of the type of ship under consideration. These conversion coefficients give an indication of the required shipbuilding capacity - expressed in manhours - to produce one gross ton, which takes into account the complexity of the production. If more yard capacity is required to produce one gross ton, the conversion coefficient has a higher value. The conversion coefficients are determined by the working party of the OECD.

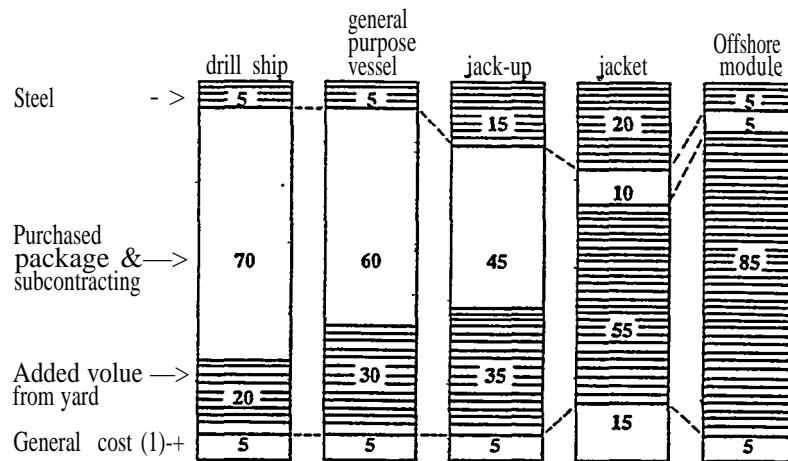
<sup>2</sup> AWES: Association of West European Shipbuilder, including the countries of the European Union (EU) as well as Finland, Sweden and Norway. The national shipbuilders organizations are represented in AWES.

continued to loose market shares.

The combination of continuing industrial growth, new market developments and the fast developing power of the Japanese industrial conglomerates initiated an industrial reorganization in the European Community. In the Netherlands mergers and take-overs led to the formation of a large industrial group in 1972, Rhine-Schelde-Verolme (RSV) owning and operating domestic and foreign shipyards and a broad scope of other industrial activities. The RSV merger took place under pressure of the Dutch government, however the expected economies of scale were, for different reasons, only partly realized. In 1983 the government refused to provide for financial help to restructure the group. Subsequently, RSV applied for suspension of payment (not to be mixed up with bankruptcy). In a very short period the group was divided into independent companies which were sold. The largest, shipbuilding facilities and ship repair facilities were stripped and closed. The newbuilding and repair capacities in the Rotterdam area alone were reduced by more than 60%.

When RSV started a total of 30,000 people were employed, of which approximately 9,000 (30%) in shipbuilding. By 1983 this was reduced to 16,000 of which 4,000 (25%) were in shipbuilding.

## THE STRUCTURE OF THE INDUSTRY



(1) Cost of financing q not included

Figure 1, Different Cost Structures of Products.

Source: Information from different Yards

The present structure of the shipbuilding industry in the Netherlands consists of small (less than 50 employees) and medium size (up to 10,000 employees) shipyards and organizations. This structure includes shipyards which

cover the entire production process on one location to enterprises which combine specialized companies at different locations which jointly represent a traditional shipyard. The yards are active in varying international markets, from dredgers to naval vessels, and sometimes combine repair and newbuilding.

Some companies are grouped in a holding with other independent operating businesses, some centralized organizations, and others operate fully independent. Key functions of an organization are combined when considered useful from a business and economic point of view. The aim is to link the effects of economies of scale, and cost advantages independent of scale, originating from experience and shared operations. Some companies successfully develop new technologies which are marketed and sold to other industries.

	Nr. of Yards	Market coverage
Japan	7	92% (●).
Korea	4	90% (●).
Finland	2	80% (●).
Netherlands	15	80% (●●).

Table I Coverage of the Market.

(o) Source: K.P.M.G. Peat Marwick (1992)

(00) Source: V.N.S.I.

Note: Market coverage expressed in cgt, (compensated gross ton), or turn-over (NL).

The effect that different types of products have on the added value, and thus on the organization of a shipyard, is shown in Figure 1. The value added by a yard may vary from 20% in the case of a drill ship

85% in the case of an offshore module'. These differences have an impact on the organization of shipyards and define the structure of the industry.

Table I compares the structure of the building industry in the Netherlands with some other countries. Approximately 15 yards cover 80% of the market in volume (cgt) and 25 yards cover 80% of the market in turn-over.

More than 250 companies in the Netherlands are called "shipyards" according to the figures of the Chambers of Commerce. Approximately 100 are a member of the VNSI<sup>4</sup>, representing some 14,000 employees. The total number of employees working in the shipbuilding industry is estimated at 19,000. Many yards are active in the international market. The traditional international shipbuilding market is still covered by some 15 yards. The industry went through a difficult cult period from 1980 - 1990, but has been restructured to fit current market requirements.

The total number of shipyards in Japan is also above 200. The production structure of the Japanese shipbuilding industry is interesting in that the seven largest yards realized 36% of the Japanese production (cgt) in 1990, and nineteen middle size yards (20,000 - 100,000 dwt) realized 38%. Some eighteen smaller yards produced 9%, according to the SAJ (Shipbuilding Association of Japan). The remaining 17% was produced by other yards. In 1992 the seven major groupings, controlling some forty yards, were responsible for 92% of the Japanese orders book according to KPMG (1) (see Table I).

In South-Korea four leading yards are responsible for nearly 90% of the orderbook, the two largest yards for 70%. Although the large yards are concentrating on tankers and bulkers, diversification is growing. A strong point is the home market. During the period of 1989-1991 an average of 95% of the South-Korean Shipowners and 98% of the Japanese shipowners placed their orders with national shipyards (1). In the European Union (EU) approximately 65% of the production capacity is for EU based shipowners.

Some conclusions can be drawn from the industrial policy of the government in the Netherlands with regard to the shipbuilding during the period from 1968 till 1983.

- The attempt to develop an industrial policy for shipbuilding, with the aim to maintain

employment,~ failed.

The economy of scale was presumably lower than expected.

- Internationalization was difficult, to a lack of time.  
Mergers came in a very short time span (3 to 4 years). Cultural and organizational differences were underestimated. Setting new targets and realizing them, involved much more than changing management or organizational structure.
- Technology, design and engineering were not a problem. Technological changes, new production systems, and CAD-CAM applications were introduced without any problems in an early stage of development. The question 'what about the financial results' is more difficult to answer.
- Creating a large industrial group did not create a competitive advantage. Smaller size companies seemed to be more successful.

## COST AND COMPETITIVENESS

Many factors influence "competitiveness" of individual shipyards. K.P.M.G. Peat Manwick (1) defines competitiveness as 'the ability to win and execute shipbuilding orders in open competition and stay in the business'. In general terms this means that a shipyard should be able to perform its key-functions at a competitive level.

The tools available to realize the objectives of a company are, according to Andrews and Christensen (2) :

- Target-markets (defining products and product development),
- Products (to be developed or being produced),
- Research and development (product- and production development),
- Marketing,
- Sales,
- Manufacturing,
- Labor,
- Purchasing, and
- Finance and control.

The specific definitions of these operational instruments by the management depend on the nature of the business."

For each production system organization, required capital and labor, as well as the requirements for the key functions, are different. This is also relevant for the qualifications of personnel, the requirements for physical resources, methodology eg for marketing and sales and the style of management.

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<sup>4</sup> These figures are based on products delivered by Dutch yards since 1968.

<sup>4</sup>VNSI: Vereniging Nederlandse Scheepsbouw Industrie (Netherlands Association of Shipbuilder)

### Cost-driven businesses.

Managing a shipyard in a changing market, formulating strategies and developing a competitive organization require insight in the forces driving the competition, as for instance described by Porter (Porter, 1988). These forces are influenced by different factors such as culture, labor conditions, industrial infrastructure and environmental rulings. Also, national policies and the relevance given by a government to the maritime-industries to create favorable industrial conditions for the development of an attractive industrial infrastructure play a role. However, most of these factors are external to a company and this requires a sectoral approach.

Shipping and shipbuilding are continuously faced with new entrants. Low-cost shipbuilders are influencing the international competition. A well developed second hand market in shipping keeps shipowners with relatively low capital investments in competition with shipowners operating with capital intensive, high-tech vessels. The available transport capacity is close to the required peak demand for capacity. A small reduction in demand has an immediate downward effect on the freight rates.

These conditions are forcing shipyards and shipowners to a continuous search for cost reductions and make these businesses primarily cost-driven, rather than technology-driven. Considering the market conditions, the shipyard activities - from marketing, through building and construction methods, purchasing (make or buy decisions), design, the role of the supplying industry, after sales services, building technologies, quality assurance, etc. - should be reviewed and analyzed as a total system, taking cost as a leading factor.

Shipyards may assist shipowners to reduce cost eg by improving the price/performance relation of a ship by proposing a better fit in a transportation system (market 'analysis), reducing the delivery times (production) or applying intelligent financial engineering. Shortening the building period and delivery time reduce financing cost for shipowners.

A cost-effective production system, production-friendly ship design shorter lead-times and financial engineering maintain the competitive position of a shipyard

### THE SECTORAL APPROACH

The sectoral analysis compares the development of 'factor costs' within the shipbuilding industries of the main shipbuilding countries, the level of subsidies is left out of consideration. As the price of most intermediate products (such as steel) are assumed to be

determined internationally and equal to every y much attention is paid to the relative cost of labor. indicator, which reflects the competitive position, is "labor cost per unit of production in a compar currency.

Since the end of the seventies a research project was started; partly funded by the government, partly the shipbuilding industry, to establish economic parameters and indicators which would enable assessment of the competitive position of the Dutch shipbuilding industry. The indicators which have been developed are:

- World market shares (based on production compensated gross tons (cgt) by country),
- Ship production in cgt by country and type of ship, indicating the degree of specialization,
- Labor costs in the shipbuilding industry (expressed in national currency), and
- The influence of the exchange rates of national currencies expressed per US \$.

The comparison of the costs in shipbuilding over a certain period are calculated on the basis of:

- The productivity of labor, measured in compensated gross ton (cgt) per man-year,
- The direct labor cost per cgt, and
- The share of the cost of suppliers and subcontractors.

The production on the world-market.

Since the middle of the seventies the production of seagoing merchant vessels is in decline. From 1975 to 1989 the production went from 20 million cgt to 9.9 million cgt. Production increased to 11.7 million cgt in 1990 and gradually to 12.1 million cgt in 1992. The position of the Japanese yards is gradually decreasing in favour of the South-Korean yards. Together they share more than 50% of the world production. The position of Taiwan, China and Singapore during the years 1985-1992 remained stable between 2% and 2½% each. At the same time the share of AWES dropped from 40% in 1975 to 28% in 1992, in favour of the American shipbuilding industry. AWES annual production averages approximately 3 million cgt's. Until 1992 Germany is the most important shipbuilding country followed by the AWES with a market share of 25 percent. Italy and Spain also form important shipbuilding countries with average market shares of over 10 percent, (see Table I and Table III).



	1989	1992
<b>ASIA</b>	<b>57.6</b>	<b>59.5</b>
<b>CPE</b>	<b>15.2</b>	<b>7.4</b>
<b>others</b>	<b>3.0</b>	<b>3.3</b>
<b>AWES</b>	<b>24.4</b>	<b>29.8</b>
<b>(of which EU)</b>	<b>(19.8)</b>	<b>(24.8)</b>
<b>Total</b>	<b>100.0</b>	<b>100.0</b>
<b>cgt</b>	<b>(9.9)</b>	<b>(12.1)</b>

Table II. World Production in Shipbuilding  
1989/1992 Share of Production (% cgt)

Note:

Asia includes:

Japan, South-Korea, Taiwan, Singapore and China.

CPE (formal Central Planned Economies) includes

Bulgaria, Poland, Roumania, former DDR,

Soviet-Union and Yugoslavia.

Source: AWES, Lloyds, Van Holst & Koppies (4).

	1989	1992
<b>Germany (incl.DDR)</b>	31.9	25.4
<b>Spain</b>	11.5	11.4
<b>Italy</b>	9.7	10.2
<b>Denmark</b>	7.4	9.1
<b>The Netherlands</b>	6.1	11.6
	66.1	77.7
<b>Total EU</b>	80.8	84.1
<b>others AWES. Finland.</b>		
<b>Norwegian, Sweden</b>	19.2	15.9

Table III. Share of AWFS Production in  
Shipbuilding 1989/1992 (% cgt).

Source: AWES. Van Holst & Koppies (4).

#### The Netherlands compared to AWES

The Dutch production varied from 170,000 cgt's in 1988/1989 to over 400,000 cgt's in 1992. The share of the production (cgt) of the Netherlands within AWES increased from 6.1% in 1989 to 11.6% in 1990, while the order intake dropped from 6.9% to 5.1%. In the period from 1984-1988 Dutch shipbuilding production varied between 9.8% (1984) and 6.9% (1988). The average order intake was around 6%. Due to their relatively strong competitive position the shipyards in The Netherlands have been able to maintain a central position as a shipbuildingcountry within the AWES. In the period 1984-1992 the Netherlands had an average market share of approximately 8-9 percent in the total AWES-production.

The five countries with the largest share in AWES production in 1992 are shown in Table III. During this period the share of the EU countries in the AWES order

intake increased from 84.1% in 1989 to 88.1% in 1992.

#### The value produced per cgt

Market share and value produced are both indicators for judging the trend of the development in an industry in the market. The production values are not unambiguous. Some countries are providing the information based on total value sold, this means inclusive indirect taxes and subsidies. Other countries do not include these. The value produced is measured as the three yearly progressive averages of the values produced per cgt in US\$ (see Table IV).

	1989	1992
<b>Germany</b>	<b>1.18</b>	<b>1.03</b>
<b>Spain</b>	<b>1.38</b>	<b>0.78</b>
<b>Italy</b>	<b>0.88</b>	<b>0.82</b>
<b>Denmark</b>	<b>0.66</b>	<b>0.64</b>
<b>The Netherlands</b>	<b>2.02</b>	<b>1.80</b>
<b>AWES</b>	<b>1.21</b>	<b>1.01</b>

Table VI. Complexity of Ships Delivered (cgt/gt).

Source: AWES. Van Holst & Koppies (4).

The values show large variations from 943 (Portugal 1990) to 3910 (Spain 1990)<sup>6</sup>.

#### The export

The production for a home market is an important issue as can be seen from the Japanese and South-Korean examples. However the market for sea going merchant vessels is an international market. The percentage of export orders is an indicator for the competitive force on the world market. In general, shipyards will try to increase the share of export orders to improve chances for continuity.

The share of export orders differs much from country to country (see Table V). Italy and Denmark concentrate on the home-market, while Spain, Germany and Finland score high for export. The share of export in the Netherlands is increasing.

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The three yearly progressive average of the value per cgt is obtained by converting production values of different countries to US\$ and then calculating the quotient between the values and cgt's produced. From this quotient the average over three years is calculated

This indicator is not very reliable because of the differences in input and the impact of the differences in Cgt..

	1989	1991
Germany	not known	69.2
Spain	48.6	74.3
Italy	3.6	0.0
Denmark	12.0	0.0
The Netherlands	24.8	49.0
EL'	35.1	45.3
Finland	75.3	100.0
AWES total	43.8	50.8

Table V. Export Share of Production (% cgt).

Source: AWES, Van Holst & Koppies (4).

The complexity of the vessels.

The complexity is measured by dividing cgt's by gt's. A high ratio is an indicator for more sophisticated and special (not necessarily complex) vessels. A relation can be made to the composition of the products. For this purpose a diversification index has been used and the compilation of ships built during a certain period. The complexity of the production is shown in Table VI.

	1989	1992
Germany	1.18	1.03
Spain	1.38	0.78
Italy	0.88	0.82
Denmark	0.66	0.64
The Netherlands	2.02	1.80
AWES	1.21	1.01

Table VI. Complexity of Ships Delivered (cgt/gt).

Source: AWES, Van Holst & Koppies (4).

Diversification

The diversification used by Van Holst & Koppies (4) has been defined as:

$$DI_c = \left[ 1 - \frac{1}{2} \sum_i \left( \frac{P_{ic}}{P_{tc}} - \frac{P_{i,AWES}}{P_{t,AWES}} \right) \right] \times 100 \quad (1)$$

- $DI_c$  = Diversification index of country  
 $P_{ic}$  = Production of i ship type in a country  
 $P_{tc}$  = Total production in a country  
 $P_{i,AWES}$  = Total production in AWES of i ship type  
 $P_{t,AWES}$  = Total production in AWES countries.

Table VII shows the diversification index (1991) for some countries:

The figures from Table VII should be seen in relation to Table III (share in production), Table V

Germany	69.5
Spain	41.5
Italy	54.6
Denmark	34.4
The Netherlands	61.6
AWES	100.0

Table VII. Diversification Index.

Source: AWES, Van Holst & Koppies (4)

(export share in % of production) and Table VI (complexity of ships). A relatively high diversification index and complexity show an increasing or high share in production and export. A low complexity and diversification (Spain, Denmark and Italy) do not necessarily go together with high export shares. Spain seems to be an exception. Table VI and Table VU show that The Netherlands is producing relatively complex vessels, in combination with a diversified building programme.

### Portfolio Analysis

In order to judge the position of the Dutch shipbuilding industry against the different market segments of the AWES market, a portfolio-analysis is performed. To this purpose the Dutch market shares of the different types of ships in the AWES production are compared with the average yearly growth of the AWES production of the different types of ships in the period 1984-1991 (see Table VIII). The AWES market is divided in ship types showing an increasing (positive) production output and ship types showing a decreasing (negative) production output (in cgt). The Dutch market share is divided in market shares above and below 5%.

	Dutch market share < 5%	Dutch market share > 5%
growth AWES positive	crude oil tankers LPG carriers passenger ships	general cargo ships reefers fishing vessels
growth AWES	bulk carriers combined carriers ro-ro vessels car vessels	product tankers chemical tankers full container ships other non-cargo vessels
negative	LNG tankers, ferries	

Table VII. Portfolio-Analysis of Dutch Shipbuilding period 1984-1991.

Source: AWFS, Van Holst & Koppies (4).

The AWES production of bulk carriers, combined carriers, ro-ro vessels, car carriers, LNG tankers and ferries decreased in the period 1984-1991. For these types of ships the Dutch shipyards had, however, a smaller market share. The AWES production of crude oil tankers, LNG tankers and passenger ships increased

during the considered period. Some market segments are expected to grow and can be considered as growth markets.

On the market segments of product and chemical carriers, full container ships and other non-cargo vessels, The Netherlands maintain a relatively strong position. However, the AWES production of these types of ships has shown a decline in the period 1984-1991. Should the decline in the demands for these types of ships continue in the AWES market then the concerned Dutch shipyards in these markets will be experiencing tougher competition.

Taking into account the relatively constant level of the Dutch market share in the years 1984 to 1992, it may be expected that in the segment of other non-cargo vessels, the Dutch shipbuilding industry will be able to withstand this possible stronger competition.

The analysis of ship types indicates that the major markets (domestic and international) for the shipyards in the Netherlands are general cargo vessels (21%), full container ships (20%), fishing vessels (11%), other "non cargo" vessels (30%), reefers (7%) and product/chemical carriers (8%). In these categories the Netherlands holds a relatively strong position in the AWES countries.

## THE COMPETITIVE POSITION

Labor costs are an important indication for the competitive position of a nation's shipbuilding industry. To make an international comparison, major factors that play roles are, labor cost (per manyear), the currency and exchange rates of the various countries, (expressed in US\$), and the production per manyear.

### Labor productivity

Labor productivity in shipbuilding can be estimated by dividing physical production employment into two types.

In view of the Labor productivity it is important to distinguish two types of employment. Direct employment concerns those employed directly by the shipyard concerned. Labor productivity has also to take into account the employment involved in subcontracted work because this contributes to the total production. For example, in The Netherlands a trend towards an increasing significance of subcontracting is observed in the shipbuilding industry. The increasing degree of subcontracting is indicated amongst others, by the fact that the share of the gross value added (which consists of indirect taxes, minus subsidies, labor costs and depreciations) in the production value has decreased from 33.1% in 1985 to 28.5% in 1992. Due to subcontracting a larger part of the value is added

outside the shipyard. In Japan the level of subcontracting is also substantial. To take relatively large fluctuations of production per year into account labor productivity is calculated as the average of the three-yearly progressive indicators of annual production in cgt's per manyear.

	productivity per cgt/ manager	labor cost per manyear (s)	labor cost per cgt (s)
European Community	63	97	150
The Netherlands	100	100	100
Former FRG	85	123	144
Japan	101	122	121
S-Korea, Taiwan	60	41	65
Poland	15	10	70

Table IX. Estimated indices for Competitive Factors for the Shipbuilding industry (selected countries The Netherlands 100).

Source Van Iliolst & Koppies (4)

An international comparison of the levels of labor productivity show that there is a difference between Japan and the average of the European Community with Japan far ahead (see Table IX). Within the European Community, The Netherlands shows the highest productivity, comparable with Japan, followed by Germany, Denmark and Norway. The level of productivity of countries like South-Korea and Taiwan are comparable with the average of the European Community. The level of labor productivity of Poland as an example of a country in transition, is about one fourth of EC's average.

### The labor cost per manyear

Within the European Community the former Federal Republic of Germany has the highest level of labor costs per manyear in US\$, about 20 percent above the average level in the European Community. The labor costs per manyear in the Netherlands are in a center position of the AWES countries and comparable to the average of the Community. Labor costs per manyear in US\$ in Japan is relatively similar to that of Germany. The labor costs of countries like South-Korea and Taiwan are about 50 percent of the average level of the European Community. The level of labor costs of Poland amounts approximately to one tenth of EC's average approximately.

### The exchange rate

The development of the exchange rates is important for an internationally operating Industry like the shipbuilding industry, because it determines the

prices of the products. The development of market prices is based on prices of ships delivered, consideration given to exchange rates. Reference with exchange rates are German Marks (DM), Japanese Yen and US\$. In particular, attention is given to a comparison between the West-European shipbuilding nations (AWES-countries), the principal South-East Asiatic shipbuilding countries (Japan, South-Korea and Taiwan) and Poland.

Within the EC some countries recently have come forward with a so called hard currency, especially the Netherlands and Germany. In relation to the currencies of these countries the value of the US\$ has decreased the most. A hard currency means a competitive disadvantage for the exports of the country concerned, because the prices expressed in foreign currencies increase relatively faster than might be expected on the grounds of national cost developments. Weaker currencies which, like the dollar have decreased in value in relation to the hard currency, include among others the Spanish peseta, the Portuguese escudo and the Italian lire. Outside the European Community the value of the Japanese yen also rose relatively large against the US\$. In the shipbuilding industry this can be (partly) countered by a well developed policy for a purchased package. Large parts of steel fabrications and equipment supply can be subcontracted considering changes in currency. It makes the financial engineering more complex and the yard has to obtain the knowledge of the risks which are involved. The Netherlands Export Credit Insurance covers for example only the value produced in the Netherlands which is a complicating factor for export financing.

#### The labor cost per cgt

The labor cost per cgt produced is calculated by dividing the labor cost per *many* year by the cgt per year. In order to correct for fluctuations in production and employment the calculation of the labor cost in US\$ per cgt is based on the average of three year production.

A comparison of the levels of labor cost in US dollars per cgt show strong differences. The South-East Asian countries, Japan South-Korea and Taiwan, have the lowest level of labor cost per cgt. considerably lower than those of the AWES countries. The level of labor cost per cgt in the Netherlands is the lowest within the AWES, with Denmark and Norway nearly as low. The level of labor cost in US\$ of the Polish shipbuilding industry has passed the level of South-Korea in the past few years.

A evaluation of the competitive factors is presented in Table IX for selected countries.

The am findings are reflected in the structure of Dutch shipbuilding industry as well as the market

policy and production approach of the individual shipyards. The industry is defined as a fragmented industry with many individually operating yards. Most shipyards are specialized in a limited number of ship types or a very specific market (eg fishing or dredging). Subcontracting and specialization in production are increasing as well. Many efforts are made to realize cost reduction. The following paragraph describes the effects of the factors discussed so far.

#### POTENTIAL FOR COST REDUCTION.

Porter (Porter, 1989) states that individual companies are able to create entry barriers to improve their competitive position. Examples follow.

##### Economies of scale.

The goal of economy of scale is to reduce the unit cost of a product or a part of a produce for instance by increasing the production volume. Enabling technologies are the industrialization of production process (prefabrication or panel-line fabrications), combining capacities to increase output implementation of new technologies through the reduction of overhead costs by joint purchasing. The structure of the shipbuilding industry in a country changes when individual shipyards are realizing economies of scale.

##### Vertical integration.

Advantages of vertical integration are the reductions of joint costs. The successive stages of production or distribution are combined. This also includes to the association with subcontractors and equipment suppliers. In practice it is nearly impossible for a shipyard to restrict the supplier or sub-contractor from using jointly developed know-how elsewhere. Also strategies leading to vertical integration are changing the structure of the industry.

##### Cost advantages independent of scale of a shipyard.

Some examples of cost advantages independent of shipyard size are:

- Favorable access to raw materials,
- Convenient geographical locations,
- Proprietary product technology?

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<sup>7</sup> *With regard to the proprietary technology the remark should be made that it is difficult in shipbuilding and shipping to protect product know-how by patents or proprietary agreements.*

- Learning curves, specialization.
- The development of standards, leading to cost reductions.

Benefits of specializing parts of the production system are found in decreasing cost per unit and capital cost. The classic learning curve (the result of experience through specialization), improved working methods, a refined lay-out and use of equipment, increased performances of labor, and better dimensional control with advanced measuring techniques are all requesting in declining costs per unit and improved quality (Schonberger, 1986).

### Engineering

A potential for cost-reduction is directly related to engineering activities. Some basic rules can be found in (Ehrenspiel, 1985) as follows.

- Reduce demands during the problem definition by minimizing accuracy and tolerances, and specify only conformance to standards.
- At concept stage use the smallest size and the lightest construction.
- Use simple and robust physical solutions.
- Reduce complexity. Limit as far as possible the number of parts, quantities, lengths, etc.
- Standardize as much as possible.

### Quality and Safety.

To measure quality and safety industry-wide, norms and standards are required as well as references to determine the "value of quality" in terms of money. There is no purpose in promoting quality in cost-driven industries if there is no financial reward. A well developed second hand market prohibits the introduction of quality in transportation when quality, and therefore safety, is not a concern of the shippers.

Safety is the result of commercial evaluations and in a few cases a matter of (incident driven) public concern. When norms and standards are not available, quality can only be measured by using administrative procedures or by judging the performance of the product. The role of classification societies and insurance companies is crucial when performance of ship and crew are to be measured. Complicating factors are the life time of a ship (up to thirty years or more), changing ownership during the life time of the ship, different modes of operation, and different attitudes towards maintenance.

### Lead times

Reduction in lead times are attainable through actions such as:

- Increasing the production capacity of a single yard
- Maximizing flexibility of labor between departments,
- Subcontracting production capacity with other yards,
- Sharing specialized production capacity with other companies,
- Increasing the productivity of the organization, and
- Simplifying the product.

Methods should be developed to judge advantages and constraints of a (combination of) solutions. The impact of new technologies and investments on products and productivity should be measured. Validation of new ideas should be done by administrative tools and scenario's enabling an individual shipyard to evaluate the cost performance of changes. Figure 2 illustrates that a major part of the costs are fixed during the design and engineering phase.

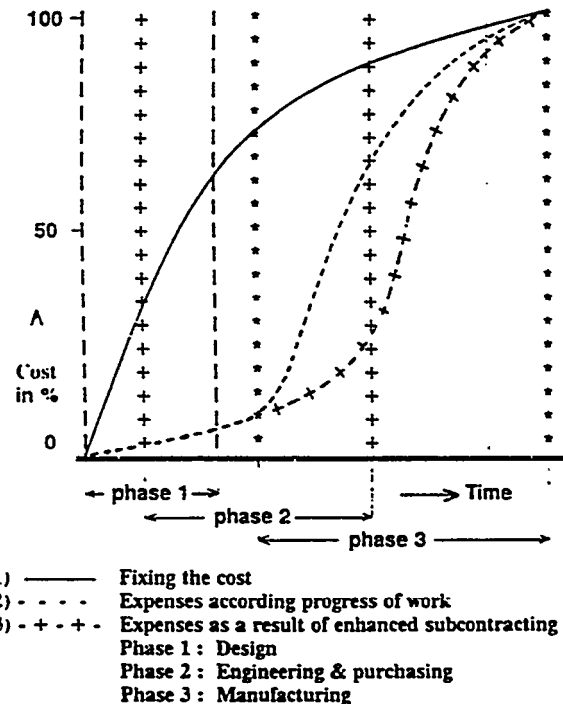


Figure 2. The Impact of Different Phases of the Production-Process on the Total Cost of a Project.

Source: Information from Different Yards

*The expenses* occurred during the contract period are shown in Figure 2. These expenses can be delayed by subcontracting. The effects of delaying these costs by

subcontracting are shown in curve (3) (compared to curve (2)). Subcontracting will delay payments (due on delivery) while simultaneously the total construction period can be shortened. This will decrease financing costs during construction.

The impact of the lead time on pre-financing cost is also reduced. Through subcontracting the expenditure curve is influenced. The total cycle of design - engineering - subcontracting - purchasing and fabrication has an impact on the cost of financing.

#### Standardization

Standardization is a matter which should get the highest priority. So far a multitude of standards have been developed in many countries. In many occasions these have been used to protect the national industries, by creating small differences in material specifications or dimensions, using different measuring systems, requiring approvals of specific testing facilities, etc.

Standardization on a national level has been leading to a diversification which has been creating barriers for further developments and competition, dividing an already small market into even smaller pieces. The necessity to stimulate the further development and application of International Organization for Standardization (ISO) standards is evident. ISO-TC8, the technical committee for shipbuilding of the ISO has been working on this for a long time.

Development of standards may under no circumstances hamper innovative developments such as open-top container ships. Standards should on the contrary, enable the industry to demonstrate the capability to develop cost-effective safe and environmentally friendly tools for waterborne transport. This means that the International Maritime Organization (IMO) rules and regulations can refer to ISO standards for rules and regulations. These standards have to be a concern of the shipping and shipbuilding industry in the first place. National authorities have to stimulate the industrial participation.

Structural and organizational changes affect the production process. Specialization of engineering and of parts of the production process enhances the productivity of the yards. Shipyards may combine efforts for R&D of advanced technologies (eg CAD/CAM applications) and new specialized production facilities will have to be developed.

Management, organization, administration.

An example of the administrative support for management is the control of progress. Changing the production system and shortening the lead times require close control of progress and cost.

Observations during studies carried out by the Delft University of Technology at Dutch shipyards confirm the views of Schonberger (5) that the lead time is a governing factor for costs. Progress can be measured, according to Schonberger, by controlling two conditions:

- All materials for a product going to the shop floor, and
- The finished product leaving the shop floor.

This type of control is only feasible if the lead time for (apart of) production is a few days.

Administrative and supervisory procedures can be simplified. For a shipyard this is not a realistic condition for all the production activities. A simple method to control cost and progress with longer lead times was developed in cooperation with a shipyard in the Netherlands. (8). The method is based on the material flow registered from the warehouse.

The "entry barriers" mentioned by Porter (Porter, 1980) are areas where cost reductions can be realized by an individual shipyard. Areas for further investigation to improve competitiveness of the shipyard are

- relations and communications of yard-management with labor to improve productivity, and

Means to improvement productivity	Required effort of management for change	Investment required for change	Improvement of:	
			labor productivity	production time with same productivity of labor
1. Improve organization	+++++	+	+++++	+++++
2. Automation	++++	+	++++	++
3. Mechanization	+	+++	++	++
4. Add personnel	+	++++	none	not realistic

Figure 3, Effect of "Actions for Change" on Productivity and Delivery Time.

Source: S. Hengst, R.W.F. Kortenhorst (1993)

evaluation of the structure of the industry ie the relationship between shipyards and suppliers or subcontractors.

*Some* views in the Netherlands are represented in Figure 3 where the means to improve productivity are set against the required effort of the management the financial means, the impact on labor productivity, and lead-time. (Hengst, 1993).

"Improve the organization" is the message, assuming that the production technology for pre-fab, and design and engineering is well developed.

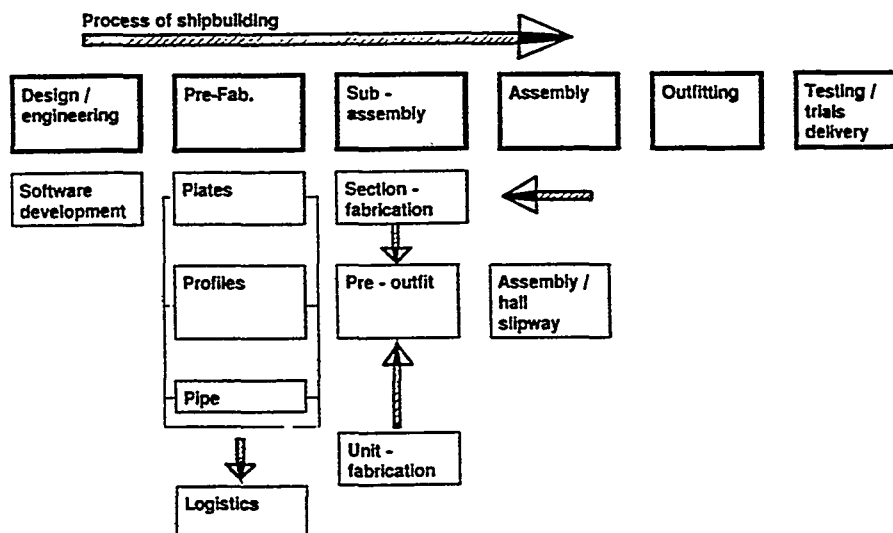
Improving the organization is demanding a larger effort from management than automation, mechanization, or extra personnel. Labor productivity will increase, leading to reductions in production time. As long as the investment for the change is low, the effect on the overall cost is evident. The effects on cost of automation and mechanization are claimed to be less.

The structure of the industry and increased subcontracting.

possible with a standardized modular approach - is demonstrated by the vertical arrows. The logistic support is generated from the desing/engineering stage by assuring that materials are combined with the necessary information for unobstructed assembly.

Design and engineering are primarily controlled by the availability of (external) information. The lead times of pre-fabrication are governed by the capacities of production facilities while the lead times of the pre-outfit depend on delivery times of the long lead equipment- The production systems in shipyards consist of different types of production processes eg process production (materials handling and pre-fab), series production (panel-line and some parts of pre-assembly) and unique product production (assembly). Suppliers can specialize in any of these production technologies.

Specialization in pre-fabrication is possible if the preparatory activities of engineering meet the required production schedules. This includes ordering of steel, the preparation of the numerically controlled pre-fabrication of plates and profiles, and the timely and



**Figure 4, Selection of (building) Policy.**

**Source: S. Hengst, R.W.F. Kortenhorst (1993)**

Reference is made to the production phases shown in Figure 4. The arrow on the top indicates the sequence of the phases of a typical production process in shipbuilding. The second from top arrow indicates the trend that the outfitting is gradually moving to the assembly and pre-outfitting stages. When the final outfitting disappears, the process, and thus the delivery period, is shortened by one phase.

The role of pre-outfitting - a combination of section fabrication and unit fabrication, as much as

precise grouping of all materials required for sub-assembly.

The type of assembly changes the requirements for engineering and work preparation compared to the traditional shipyard. Engineering and the preparation of the work may be subcontracted to suppliers of modules or completely pre-outfitted sections.

Strategic selection of production activities.

The selection of production activities for a shipyard - ie a "make or buy" decision - should be based simultaneously on analysing cost, lead time and quality. A shipyard has to decide which parts of the production are to be considered as core activities of production, essential for the continuity of the company. The preparation of such decisions requires tools for the management to be able to evaluate and compare different options and develop solid financial and economical policies. The conditions will vary for each individual shipyard and the product selection made by the yard. In other words a niche-market approach and specialization require a careful review of the production system. Building dredgers is not the same as building chemical carriers.

### CHANGES IN SHIPYARD ORGANIZATION

Traditional shipyards were based on *vertical integration with the* fabrication of as much equipment as possible, such as changes, turbines and main-engines, as well as facilities for all aspects of production including foundries, machine-shops, pipe-shops and carpenter work. It included nearly every type of work required to build a ship and "added value" to shipyard production. The total production process was fully controlled at a yard. Delivery times were controlled by spreading and levelling capacity of the yard, or by subcontracting.

Spreading the shipyard capacities to subcontractors and suppliers may be called "*horizontal diversification*". Horizontal diversification of the production process (through subcontracting) puts constraints on the effectiveness of the production process of a shipyard. The effectiveness of an organization will depend on the size of the operation.

For smaller size yards problems may occur, because the balancing of the capacities of departments to obtain the shortest possible lead times becomes more difficult. Efficient use of the production facilities of a department, eg by increasing the production volume to the maximum capacity, may not be possible. The opportunity to obtain reductions in cost per unit remains unused in situations where capacities cannot be balanced. Particularly in case of batch- or process-type production systems, cost reductions can not be realized when the production capacity of a unit cannot be fully employed, such as when limited to the demand of one shipyard. The total production system does not usually allow for levelling the production capacities of single departments. Moreover, the degree of utilization of equipment and machinery will vary as a consequence of different types and sizes of ships which are under

construction. The production system under these conditions is faced with additional rests which have to be accepted.

Changes in The Netherlands.

Specialization of subcontractors and suppliers initiates changes in the shipbuilding industry and makes it possible to buy an increasing amount of equipment and services from suppliers. The cost structure shown in Table X illustrates the importance and the effects of the changes in the industrial structure as shown in Figure 5.

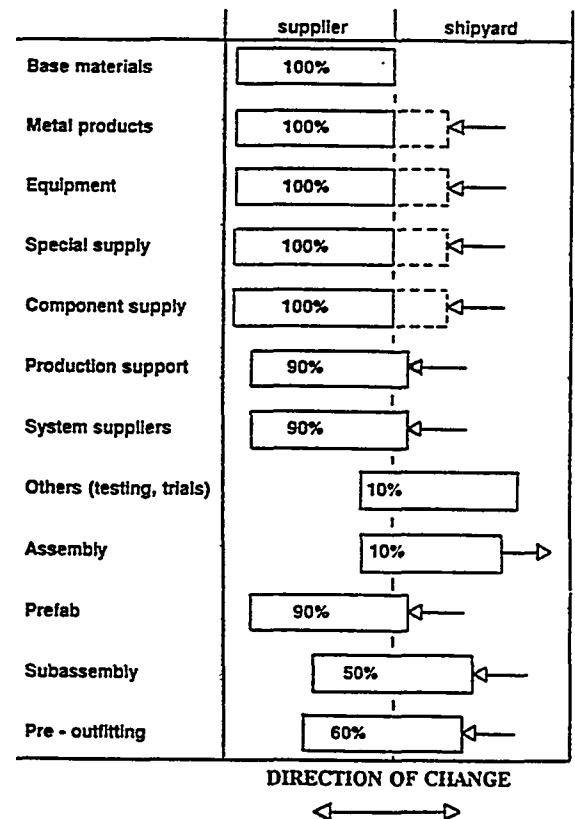


Figure 5, Changing Structure of the Industry  
(illustrative only)  
% of work moving to suppliers

Source: Information from Different Yards

These changes in the structure of the industry are the result of the need to improve the competitive position, and coincides with the strategic development towards diversified niche-oriented shipyards. This is confirmed by the findings of Van Hoist & Koppies.

A process of *horizontal diversification* combined with specialization means increasing Subcontracting without, affecting the market-position of shipyards. "Make or buy" decisions are becoming a relevant topic



• **Materials** (increasing)

- base materials	7%
- metal products	6%
- equipment	24%
- special supply	3%
- system suppliers	15%
- component suppliers	3%
- others	2%

• <b>LABOR</b> (decreasing)	60%
• <b>CAPITAL CHARGES, SERVICES</b> (increasing)	30%
<b>TOTAL</b>	100%

Table X. Cost Structure General Cargo Vessel

Source: Information from Different Yards

for a shipyard to reduce cost. The result is a different industrial infrastructure. The effects are to be found in purchasing<sup>8</sup>.

introduced and yards specialize in specific markets and types of ships. In The Netherlands this has been leading to an improved competitive position in the AWES confirmed by a gradually increasing market share.

Two types of specialization (which have apparently no relation) can be noticed.

- The specialization of the shipyards. The advantages of the niche-market approach of Dutch yards has been successful so far.
- The specialization of the subcontractors and suppliers as a result of the enhanced subcontracting of the yards.

Shipyard specialization is combined with increasing complexity and diversity of products. At the same time the productivity of shipyards is increasing. Both in Japan and in the Netherlands this is combined with an increasing amount of subcontracted work. Apart from productivity improvements resulting from modularization and pre-outfitting, the productivity is apparently improved by specialization of the subcontractors and suppliers. Not only are total engine room or pump room installations subcontracted to specialized subcontractors, but also pre-fabrication, pre-

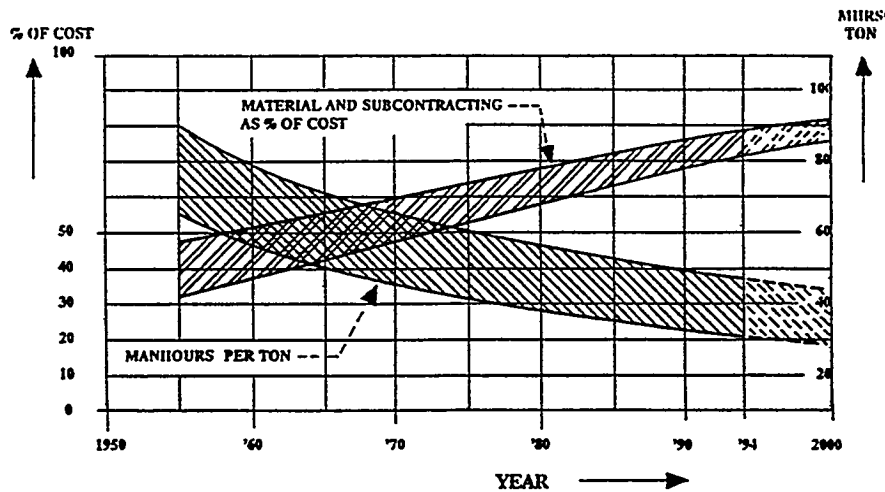


Figure 6, Development of Added Value Compared to Material + Subcontracting

Source Information from Different Yards

Shipyards should concentrate on core production activities. Production is no longer just a matter of combining available manpower and physical capacities, or trying to build any type of ship. Market analysis is

<sup>8</sup> The aim of some (eg Japanese) yards is to reduce the added value of the yard 30- 35% of the total cost of the ship to 10- 15% in the coming years.

assemblies, panel-line productions, stem and bow sections, double bottom and shells, etc.

To explore where further progress can be achieved, the effects of improving the quality in the upstream stages of the production process (engineering, purchasing, material handling prefabrication) will have to be included in the evaluation and weighed against the impact on the production stages down-stream the process, eg the assembly.

Other savings may be found in sharing investments in eg the up-streams activities between different shipyards. In the northern part of The Netherlands some eight yards combined investments in engineering (CAD-CAM), soft-ware development, pre-fabrication etc. The required capital demand up-stream, as sophisticated computer applications costly up-front research and software, are limited with combined purchase and shared operation between shipyards and subcontractor. The competitive advantages of such an operation are proved in international competition.

The advantages of horizontal diversification are spreading of capacity to subcontractors, resulting in an increased flexibility of a yard, maintaining the capability to realize short lead times in combination with cost-reductions. Individual yard capacity is then no longer a decisive factor for lead time or capacity.

The effects of these developments in The Netherlands are shown in Figure 6. The percentage of material and subcontracting, as a percentage of the total cost, has been gradually increasing during the last 45 years. At the same time the manhours per ton constructed steel have gradually fallen.

The trend is confirmed by the findings by Van Hoist & Koppies, indicating that shipyard productivity (based on a three yearly progressive average) increased from 42 cgt per manyear in 1985 to 81 in 1991, showing a yearly growth of 11.5%. For comparison, the figures for Japan are 69 and 82, South Korea 23 and 35.

The threads of horizontal diversification.

The attitude, bargaining power and the strengths and weaknesses of the suppliers to the shipbuilding industry are becoming more important. The shipbuilding industry is often not a first priority customer for suppliers because the market volume is limited compared to the total sales volume of the supplier. A relationship between equipment suppliers and shipowners (eg paint navigation equipment or propulsion systems), weakens the position of shipyards. Yards may then re-investigate vertical (backward) integration. On the other hand, the cost of a product from suppliers sometimes represents only a small part of the total cost of a ship, and the penalty for failure or late delivery of equipment (or ship) may be high in relation to the cost of vendor supplied items. A reliable supplier is then of the essence.

Another question is how far the process of *horizontal diversification can be used* without weakening the position of a shipyard. A problem may be the niche market selection. A shipyard may try to cover as much of any market as physical capacity will allow. On the other hand, the advantages of niche markets are evident as shown before, and this may

oblige a yard to maintain manufacturing functions which are indispensable for product development.

A shipyard might be caught in a strategic "trap":

- maintaining a capacity for a specialized share of the market, running the risk of "idle periods" or
- serving larger parts of the market with the same capacity acting as a jobber at "cut throat prices".

**Horizontal diversification** of the industry means enhanced subcontracting and has the advantage of

- spreading the capacities,
- increasing the flexibility of the individual yards, and
- maintaining the capacity of the industry.

In order to be able to take a strategic "make or buy decision" a yard has to decide which parts of the enterprise are to be considered as *main functions*, *indispensable* (conditional) *functions* and non-essential *supporting functions* for the continuity of the company. The preparation of such decisions may be supported by an analysis of different scenarios comparing different options and developing financially and economically justified policies.

The building of a steel hull, which represents approximately 75% of the added value from a shipyard to the cost of a ship for the merchant marine, is also no longer one of the core manufacturing activities of the shipbuilding industry. Production concentrates on final assembly, and final assembly is becoming one of the major shipbuilding activities. Sub-assembly and pre-outfitting are more frequently subcontracted to specialists<sup>9</sup>.

The main reason for these changes are initiated by the need to remain as a seller on the buyers side. The added value of the shipyard is no longer the decisive factor. Financial aspects such as currency, quality, service and standardization of the suppliers are becoming essential factors.

## EXPECTED MARKET DEVELOPMENTS

The expectations are that transatlantic and intercontinental shipping will show increasing sizes of container vessels, and other cargo vessels able to carry.

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*' An illustration is the view that the building and construction of a steel hull is typical for a shipyard. Some shipyards in the Netherlands prove that this is no longer the case (Damen Shipyards and Central Industry Group). The shipbuilding industry is getting more and more concentrated on the final assembly of the ship, with testing, trials and delivery on one side and marketing, design & engineering on the other side.*

cargo in bulk a similar development as has been seen by tankers and bulk carriers. Containerization is expected to increase and may get the characteristics of bulk transport. According to the studies carried out by the Port of Rotterdam, container traffic will grow by more than 300% in the coming 15-20 years. The cargo will be more and more "condensed" and "concentrated" in volume and size. The increasing ship sizes for intercontinental transport will lead to the "hub and spoke principle with mainports. On-shore long-distance trucking continues to increase, but expectations are that the relative growth of railways and watertransport (coastal and inland) will be bigger.

Some effects are shown in figures 7, 8 and 9. Figure 7 illustrates the case of two mainports in Europe, one in the North-West region and one in the Mediterranean region.

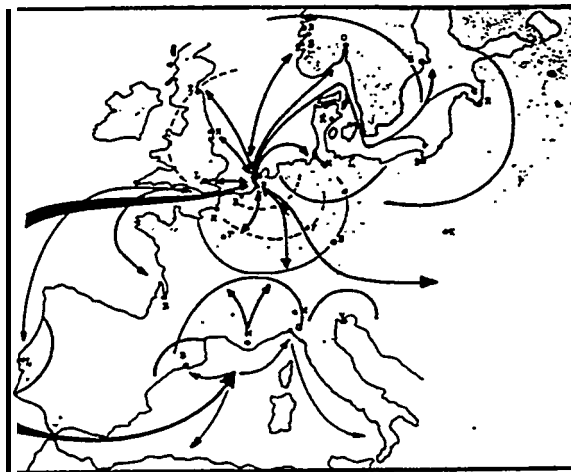


Figure 7, The Changing Market (1)  
(Hub and Spokes).

The hinterland is served from a mainport by sea-to-sea, sea-to-inland waterway, sea-to-train and sea-to-truck transfers. The different modes of transportation (the modal split) will cover specific markets, related to the types of cargo. Feeders may cover distances of 1000 - 1400 Km (600 - 850 mi) in two days. Trains may cover 2000 kilometer (1240 mi) in less than a day.

Figure 8 illustrates the coverage of different parts in the European Union (EU) for a one day trucking distance from different ports and shows that the hinterland cannot be served by a one day trucking system.

Figure 9 illustrates the enhanced coverage by the railway and inland waterway system, covered from the port of Rotterdam in combination with a one day trucking distance. Coastal and inland waterway shipping are expected to develop gradually into point-to-point services over the long distances (>250-350 km, >150-200 mi). This will lead to more transportation

by ro-ro, container and dedicated cargo ships.



Figure 8, The Changing Market (2)  
(One Day Trucking).

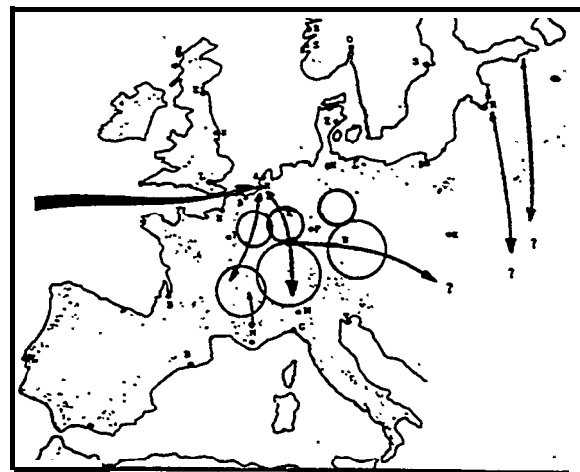


Figure 9, The Changing Market (3)  
(Effect Inland Waterway Transportation).

For shipbuilding, it is expected that the competitive position of The Netherlands can be maintained. This, amongst others, is explained by:

- A modest growth of the labor cost during the second half of the eighties compared to other AWES countries,
- The level of production per manyear,
- The relative low level of labor cost per cgt,
- A well defined niche-market approach and
- A cost-effective application of advanced production technologies.

Competition from shipbuilding countries in Central and Eastern Europe is expected to increase.

Although a modest growth in labor cost in The Netherlands is foreseen, the international competitive position of the Dutch shipbuilding industry is expected to be hindered by an increasing value of the guilder.

The expectation is also that shipyard added value will further decrease and subcontracting and supplier content of the price will increase. Flexibility and quality of labor will have to increase further.

Purchasing will become more and more an international matter, taking advantage of changes in exchange rates and international (ISO) standards.

Shipyards capable to meet the international competition

- Are able to operate on an international level,
- Take advantage of production facilities and suppliers using cheap labor, anywhere in the world,
- Trace international means for financial engineering
- Utilize to a maximum extent the advantages offered by changes in exchange rates,
- Develop innovative cost-effective and market-oriented designs and
- Use standards which will allow for cost-effective world wide purchasing.

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